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SUGGESTIONS FOR THE DISPOSAL OF BRUSH
IN THE NATIONAL FORESTS.

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SUGGESTIONS FOR THE DISPOSAL OF BRUSH IN THE NATIONAL FORESTS.

INTRODUCTION.

The piling and burning of brush on the National Forests has been required for the purpose of fire protection, but experience has shown that it is not always advisable. Every case should be considered separately and the question of brush disposal settled according to the special needs of the area in question. This circular has been prepared in the Office of Silvics, and is issued to give supervisors suggestions and to guide them in the experiments they are expected to make to determine the best methods of brush disposal on each Forest.

ADVANTAGES OF BRUSH BURNING.

PROTECTION AGAINST FIRE.

The greatest advantage of brush burning is the protection it gives against fire. In many cases brush burning is the only practicable safeguard against fire. After the average lumbering operation the ground is covered with slash, scattered about or piled just as the swampers have left it. This, in the dry season, is a veritable fire trap. Probably 90 per cent of all uncontrolled cuttings are burnt over, which retards the second crop at least from 50 to 100 years and perhaps permanently changes the composition of the forest. Fires may be set by loggers while still at work on the area, or for several years after by lightning, campers, or locomotives. By piling the brush and burning it in wet weather or in snow, when there is no danger of the fire spreading, all inflammable material is removed, and the second growth can come up without serious risk of being destroyed. Even where only part of the brush is burned and the rest is piled, as when the piles in open places, along ridges, streams, or laid off lines, are burned, very much is gained in case of fire, since these cleared lanes form bases from which a fire may be fought.

Besides lessening the danger from fire, brush burning has certain minor advantages. When the brush on the ground is removed it is much easier for rangers and others to ride or walk through the forest. This may be very important in case of a fire or in rounding up cattle. It is also much easier to cut and handle ties, cordwood, or other timber which may later be taken from the cut-over area if the slash

is out of the way. By piling and burning the green brush as it is cut from the trees by the swampers, as is now being done in Minnesota and parts of Montana, the ground is cleared and skidding is made easier and cheaper. Again, careful piling and burning of brush improves the appearance of the forest. There is nothing much more unsightly than a recently cut-over area where no attempt has been made to dispose of tops and lops. Near towns or resorts and along roads or streams frequented by tourists this point should be carefully considered, but as a general rule the utility of the forest should not be sacrificed for beauty.

PROTECTION AGAINST INSECTS.

Brush burning is often supposed to be a safeguard against noxious insects, but according to information from the Bureau of Entomology this is true only in certain cases and to a limited extent. Some of the most noxious insects do not go into the brush at all, but breed only in the living trees. Others breed only in the top logs or large limbs that are usually left on the ground in brush piling, while still others breed in the brush, but leave it within 30 or 40 days of its being felled. In these cases the ordinary methods of piling and burning brush would do no good in controlling the insects. But some very serious pests remain in the slash all winter, and these, where they are numerous enough to be a menace, can be controlled by fall, winter, or spring burning. Each case needs special regulations, and it is essential that accurate and reliable information on the species and its habits should be secured before brush is burned as a protection against insect pests.

DISADVANTAGES OF BURNING.

The disadvantages of burning brush are many and, with the one exception of protection from fire, far outweigh the advantages. If protection can be had in some other way, as with more efficient patrol service or more stringent laws, the practice should in many cases be abandoned. In many places, especially in the yellow pine type, the best and often the only reproduction comes up under a fallen tree top or other brush. Where there is little of the old stand left, the straggling open top protects the seedlings from the direct heat of the sun. Yet brush not only protects the seedlings from the sun, but, what is more important, the leaves and broken twigs form a cover which retards evaporation of moisture from the soil. Over the greater part of the West the soil dries out very rapidly during the dry season, and this seriously retards or even prevents the growth of seedlings. Even in the moister regions, such as that of the Engelmann spruce type, it is very necessary to conserve the moisture in the soil after logging, to prevent the remaining

trees from being killed through lack of soil moisture. A third reason why seedlings so often come up only under the down tree-tops is that they are protected from stock. Next to drought, sheep are perhaps the most serious menace to reproduction, and though it would be best to keep all stock off the area for several years after logging, in many cases this is not practicable, and on many areas the leaving of the tops on the ground is the only way to protect reproduction from injury.

In many places, after the timber has been cut off, gullies and washes start in the old wheel ruts, log slides, etc., and these and other forms of erosion can best be prevented by leaving the brush on the ground, either laid in the incipient washes or scattered over the soil that is likely to wash. Brush burning destroys the valuable soil cover, and on the spots where the piles are burned the soil is loosened, which renders it even more liable to erosion.

It is well known that where the forest is burned each year the soil becomes poorer and poorer, because nitrogen, the chief fertilizing ingredient of the soil, is given off in the smoke, and only the mineral elements go back to the soil in the ashes. And what is more injurious, the humus, i. e., the decomposed vegetable matter in the top soil, is destroyed. In burning brush after logging, all the fertilizing and humus-forming leaves and twigs are destroyed just when most needed, for another good crop of leaves can not be expected for many years.

The burning of brush not only removes from the soil its natural manure, but renders it unfit for the germination and growth of seedlings. This is especially true of Engelmann spruce. Douglas and white fir also, in the Southwest, will not come up after fire. The area of ground covered by piles for burning varies according to the type and to the density of the forest, but an average of from 5 to 10 per cent of the total area is thus made nonproductive. If full reproduction could be procured on the rest of the area, this would make very little difference, but where reproduction is scattered and hard to procure, as in the Southwest, it would probably make considerable difference in the final stand.

The added cost both to the lumberman and to the Government is another argument against brush burning. The cost of piling brush has varied all the way from 15 cents to \$1 or more per M, with an average of 40 or 50 cents, while the cost of burning may be from 5 cents to 25 cents per M, averaging about 15 cents. By abandoning the practice of brush piling this 60 cents a thousand will not be entirely saved, as is claimed by some, for the brush will still have to be lopped and disposed of in some other way, which will cost, it is estimated, at least half as much as piling and burning. But even a saving of 25 or 30 cents a thousand is a strong argument against the practice.

Thus, from a silvicultural view point, the disadvantages of brush burning far outweigh its advantages. Yet as a general policy it seems unwise, until other methods have proved their efficiency, to abandon brush piling and burning to any great extent at present. The fire danger is a known quantity, and though it is being reduced each year, it is still a menace. Therefore changes from the present practice should be made with caution. Brush piling and burning is certainly not advisable in all cases, and extensive experiments should be made to determine what is the best method of brush disposal for the different types and conditions.

BRUSH PILING AND BURNING.

The first care in connection with brush piling should be to see that the trees are felled into the most open ground, away from standing trees and reproduction. By doing this a large part of the cost of piling may be saved. Forest officers should not only tell the piling crew exactly how the brush should be piled, but should lop some boughs and make a few piles for them, explaining at the same time how to choose the place for the pile, how to trim the brush and put it in the pile, and why the larger sticks are left on the ground. A little showing is worth a great deal of telling. In piling brush, all the branches should be lopped so that the main stem of the top lies flat on the ground. The longer limbs should be cut up. Wood over 3 or 4 inches in thickness should not be included in the pile, but should be cut so as to lie evenly on the ground and left to rot. The one exception to this rule is in the case of burning to destroy insects. Then all tops should be included, so that their bark at least shall be scorched. Piles must not be made on down logs or stumps, except in the special case mentioned above, since the charring of green logs prevents their rotting, and dead logs, when they once catch fire, are very hard to put out, and will sometimes burn for days without being noticed, finally to break out into a dangerous fire. For the same reason brush should not be piled near dead standing trees. As a rule brush piles should be from 5 to 10 feet in diameter and from 3 to 5 feet high. Piles should not be nearer to living trees than from 15 to 20 feet; a safer distance would be from 30 to 40 feet. On hillsides the piles can be made nearer to the trees below than to those above them, and nearer to low, small reproduction than to that which is taller.

The Forest officer in charge must be the judge as to how thoroughly the ground should be cleaned. Where reproduction is small and dense, and a running fire would be likely to kill it all, more care in cleaning up broken limbs and rubbish is necessary than where the ground is bare.

The cost of piling varies with the cost of labor, the methods of logging, the type, the topography, the kind of trees cut, and the time

of year it is done. A few figures will illustrate this variation. In the yellow pine type in Montana an addition to the swampers' wages of 15 cents a thousand would, it is said, enable them to pile the brush, as they have to handle it anyway. Usually, however, the piling is done by a separate crew. Much of the work is thus duplicated. In yellow pine in the Southwest brush piling costs from 45 to 50 cents, while in Montana it can be done for 25 cents. One operator in lodge-pole in Montana says it is cheaper for him to pile than not to, because he can get his skidding done so much cheaper, yet on other operations it has cost from 50 cents to \$1 a thousand, depending on how thoroughly it is cleaned up. In the sugar pine-yellow pine type of California the cost of piling averages from 25 to 35 cents, while the cost in the Douglas fir type, in Montana and Idaho averages about 40 cents and in Engelmann spruce type the cost is only about 25 cents a thousand. It is certain, however, that the cost of piling will everywhere be materially reduced when the operators begin to look on piling as part of the swampers' regular work and not as an entirely separate job.

Dry brush should never be burned during the dry season, unless absolutely necessary for the suppression of an insect invasion. Green brush in some places may be burned at any time, but as a rule it is unsafe to burn it in dry weather. The best time to burn brush is in the fall, just after the first snowfall. Then the piles are dry, and there is no danger that the fire will get beyond control. Brush may also be burned at the beginning of *or during* the rainy season, when the ground is damp enough to prevent the fire from spreading and the brush dry enough to burn readily. The number of piles to be lighted at the same time will depend altogether upon local conditions. If there is any danger of the fire spreading it is a good plan to light alternate piles, and when these have burned to fire the intervening ones. This method will lessen and break up the fierce drafts of heated air and flame that often result from burning contiguous piles, and many seedlings and young trees between the piles will be saved which would otherwise be destroyed. Piles should be fired on the side away from the wind. On a hillside the piles at the top should be lighted first.

The methods of setting fire to the piles will vary with weather and other conditions. If the weather is very dry each pile must be set separately, but if it is damp or snowy enough to prevent the fire from spreading, a firebrand may be taken from a lighted pile and carried to the others. A forkful of live coals may be necessary to kindle a water-soaked pile. A four-tined fork will nearly always be found of use in throwing the piles together after they have burned down, or in carrying fire. If much brush is to be burned an ordinary torch or flambeau, such as is used in political or other processions, with a long handle, will be found useful. This can be carried from pile to

pile without danger of sparks spreading fire, and can be thrust into the center of the pile, where the material is driest and most inflammable. A cheap and handy torch, and one that has been found very effective, can be made by wrapping an old piece of burlap or cloth around the end of a stick or iron rod, winding it with wire, and saturating it with kerosene oil.

The cost of brush burning varies like the cost of piling. It varies even more in the same localities, with weather conditions and methods of piling. Brush that can be burned for 10 or 15 cents a thousand at a favorable time, as just after the first snow, will cost five or ten times as much to burn in dry weather or when the piles are very wet. Brush can be burned more easily the first fall after cutting than it can the second year, when many of the leaves have fallen off. Brush burning has been done for 13 cents a thousand in lodgepole in the Medicine Bow, while it has cost 22 cents in similar timber in the Yellowstone, and estimates of 40 cents a thousand have been made for it in the Rockies. It is generally admitted that brush can be most economically burned by the same people who pile it. Recently several contracts have been made in which the purchaser of the timber is required to pile and burn the brush under the direction of Forest officers, as has been the practice in the Minnesota Forest for some time. This will lighten the total cost, and when the weather allows the brush to be burned as logging proceeds the cost of burning will be offset by the subsequent reduction in the cost of skidding.

PILING WITHOUT BURNING.

Brush piled properly, even though it is not burned, is a great protection to the forest. Inflammable material is removed from among the living trees, and should a fire occur it would be much easier to fight. This is especially true where reproduction is dense. Where openings are scarce, piles should be made in the most open places, and may be larger than those made to be burned.

Where the brush is piled but not burned, fire lines should be made at intervals of from a quarter to half a mile through the cut-over area. This can be done by burning the piles in a line from 200 to 300 feet wide. Open ground should be selected, because a better fire line can be made there, and because less reproduction will be injured in the burning. In broken country the best places for fire lines are along trails, roads, ridges, or streams. In more open country they may be made along section and quarter-section lines or where the ground is open and free from reproduction, underbrush, etc. These fire lines need not be straight, but may zigzag to take advantage of the openings.

GROUND BURNING.

Where clear cutting is practiced and fire assists the reproduction that is wanted, ground burning is sometimes advisable. The slash is left scattered as in primitive lumbering operations, and after an efficient fire line has been made around the area it is burned off clean. The fire line should be thoroughly cleaned up before the area is fired. Great care will have to be exercised to prevent the starting of a crown fire, which can not be controlled, even with wide fire lines. The brush should usually be fired against the wind, and should the wind change after the fire is started the brush on the opposite side of the tract should be back fired. This method is the only practical way to secure reproduction of desirable species in some parts of the country.

LOPPING AND SCATTERING.

Where it is best to lop the tops and scatter them over the ground, the lopping should be done thoroughly, so that the top logs and larger branches will lie flat on the ground. If the object is to prevent erosion, the brush should be scattered or roughly piled where washing is most likely to occur. If washing has already started in wheel ruts, log slides, etc., brush should be laid in these as compactly as possible. If good-sized gullies have formed, it is usually better to put the brush in them in compact piles, filling them from side to side, than to scatter some brush all along them. If the chief object in scattering the brush is the conservation of moisture, it should be scattered evenly over the ground within reasonable distance of where it is felled, care being taken to keep the brush at safe distance from reproduction or living trees. Where brush is scattered, fire lines should be made at intervals by piling and burning the brush in lanes 200 or 300 feet wide. This diminishes very greatly the danger from fire, by isolating different areas in the forest, and giving places where back firing can be started. The cost of lopping and scattering brush in this way has not been determined, but it is thought that it can be done for from 50 to 75 per cent of the cost of piling and burning.

FOREST REGIONS OF THE WEST.

The forests of the western United States may be grouped into several more or less definite silvical regions, which are determined chiefly by the amount of rainfall and moisture in the air, though partly by temperature.

This grouping has been followed in this circular, except that the northern and southern Rocky Mountains, which have been usually made two silvical regions, are here combined as one. Methods of handling the brush differ more between types than they do between

the regions. Similar types in different regions can often be handled in the same way, but the different types even in the same region should usually be treated quite differently.

METHODS OF BRUSH DISPOSAL ON DIFFERENT TYPES.

CASCADE REGION.

The Cascade region comprises that part of Washington and Oregon west of the summit of the Cascade Range. It is a region of great humidity and heavy rainfall, so that the question of fire protection is not as important here as in other parts of the West.

Four general types of forest are recognized: Hardwood bottoms, Douglas fir and hemlock type, fir type, and Alpine type. Only the second is of any commercial importance at present.

Hardwood bottoms are the comparatively small areas along the rivers and streams on which maple, cottonwood, and other hardwoods are most abundant, though the principal timber tree is giant arborvitæ (western red cedar). Where this tree is cut, as it often is, for shingles, the brush should be piled, but not burned, or else lopped and scattered carefully. Burning the soil often prevents the reproduction of arborvitæ.

Douglas fir and hemlock type covers the greater part of the slopes and benches below 4,800 feet. At present practically all the lumbering of the region is done in this type. Douglas fir is the most valuable tree and the most abundant, but hemlock, which is a much less desirable species, is able to come up under dense shade and always covers the ground after logging, crowding out the more light-loving Douglas fir. The only way to destroy the hemlock and let the fir come in is to burn the area off after logging. The exposed mineral soil makes an ideal seed bed for Douglas fir, while hemlock will only come up on a vegetable mold. Ground burning should therefore be adopted in this type for three reasons: (1) It is the only way to get Douglas fir reproduction. (2) It is a protection against fire, for by burning off all the brush and débris when the ground and standing timber are too damp to burn, dangerous ground and crown fires, which in this region have been very destructive, are prevented. (3) The stands are so heavy and the amount of brush so great that piling is impracticable in many cases.

Fir type lies above the Douglas fir and hemlock type and is more inaccessible. For this reason, and because the two most important trees comprising it, the noble and amabilis (lovely) firs, are of inferior quality, it has as yet been logged very little.

Alpine type is the scattered timber growth above the fir forest. There is no logging in this type, and probably will not be for many years to come, as there is practically no merchantable timber in it.

SIERRA DISTRICT.

All the forests in central and northern California are included in the Sierra district. Here there is a much lighter rainfall than on the western slope of the Cascades, and the dry spells are more prolonged, so that fire is an important problem.

Four distinct types of forest are recognized: (1) Foothill type, (2) yellow pine-sugar pine type, (3) fir type, (4) Alpine type.

Foothill type is the open stand of various species of oak, together with digger pine, that occurs in the foothills just below the true timber forest. No lumbering is done in this type, and the only cutting likely to occur will be for cordwood or posts. The ground is dry and loose and subject to erosion, and reproduction is hard to get, except under partial shade. Brush should be lopped and scattered over the bare soil, or put in gullies, washes, etc., or piled in long, low piles around the hillside. Only in rare cases should it be burned. Though the danger from fire is great, yet the trees are so scattered that the fire risk would not be greatly increased by leaving the brush unburned, and the advantages of leaving a cover on the ground are very great.

Yellow pine-sugar pine type comprises the bulk of the commercial forest, and in elevation extends from about 1,500 feet up to 5,000 feet in northern California and from about 4,000 feet to 8,000 feet in southern California. Yellow pine and sugar pine are the most important trees numerically and commercially, forming 50 per cent of the entire stand. The danger from fire in this type is so great that every precaution must be taken. Therefore the brush should in nearly all cases be piled and burned. On bare southern slopes, where the soil is loose and easily washed, and where there is no reproduction, it may be best to lop the tops and leave the brush on the ground to protect the soil, in an effort to get reproduction, but fire lines in the slash should always be made if this is done. In dense patches of reproduction the piles might be left unburned if effective fire lines are made.

Fir type.—As the elevation increases, the proportion of yellow pine in the forest decreases, while that of white fir increases until it forms in some places a pure stand. Reproduction of sugar pine and yellow pine must be encouraged at the expense of white fir. There is less danger from fire in the fir type than in the yellow pine-sugar pine type, yet the stands which are lumbered usually contain a large percentage of pine, and the brush should be piled and burned as in the type below it.

Alpine type consists of more or less pure stands of California red fir and of black hemlock, with a scattering of western white pine, and extends from the fir type up to timber line. No cutting is done in the alpine type, and the disposal of brush need not be considered here.

ROCKY MOUNTAIN REGION.

The Rocky Mountain region extends from the Canadian line to southern Utah and Colorado and from the eastern Cascades to and including the eastern slope of the Rockies. The northern part of this region, and especially the northwestern part, differs considerably from the part in Colorado and Utah, and from a silvicultural standpoint it should be divided into two subregions. But since everywhere the main types are the same it can be treated as one region.

Four main forest types are found in the Rocky Mountains: (1) Yellow pine; (2) Douglas fir; (3) lodgepole, and (4) Alpine type. One or two others may be found on restricted areas in a few of the National Forests, but for purposes of brush disposal they can be classed under one of the other types.

Yellow pine type is found on the drier slopes of the lower elevations. The disposal of brush in this type should depend on the reproduction. Where this is good, brush should be piled and burned only where the risk from fire is greatest, but fire lines should be made at intervals. Where reproduction is poor or absent, and this can be attributed to the dense ground cover of grass, brush should be piled and burned. If this is done, the breaks in the turf made by the fires will furnish a starting place for reproduction. Where the soil is bare of both ground cover and reproduction, brush should be lopped and scattered over the area to protect the soil from drying out and washing and to give the seedlings shelter from the sun and protection from cattle.

Douglas fir type occurs throughout the region, but is not often found pure, being mixed with yellow pine, lodgepole, limber pine, etc., and grading into the types above and below it. It occurs above the yellow pine type, requiring rather more moisture than the latter tree. On some forests Douglas fir is the most important tree commercially, while on others, owing to its limited occurrence or poor quality, it is comparatively unimportant. Reproduction as a rule is fair and can usually be secured after logging if proper precautions are taken. Unlike the same tree in the Cascade region, fire hinders reproduction, and burned-over areas are likely to become barren or grow up to lodgepole, a less desirable tree. In this type brush should be piled as a measure of protection, but burned only where the danger from fire warrants it. Fire lines, as recommended for other regions, may be quite sufficient.

Lodgepole type is the one characteristic of the region. It is found in all the forests and is by far the largest and most important one. It occurs naturally above the Douglas fir type, but often extends down through it, especially on old burns. The lodgepole pine is usually in pure stand, but on suitable areas Douglas fir is mixed with it on the

lower elevations and Engelmann spruce on the higher ones. Where these occur the treatment should favor these species. Brush should be piled as far away from these species as possible and burned when snow is on the ground. Where lodgepole is in pure stand, reproduction after logging is certain, and the chief care should be to keep out fire once the seedlings have started. Since reproduction comes up densely after fire, ground burning might be well after clear cutting. This is not recommended, however, since the destruction of humus works injury to the forest. In all cuttings of lodgepole pine, brush should be piled as far as possible from live trees and burned when the snow is on the ground.

Alpine type occurs throughout the Rocky Mountain region at the higher elevations, occasionally extending down the moister canyons and streams into the lodgepole or Douglas fir types below. In the northern part of the region alpine fir is the dominant tree, and the forest is not yet merchantable, so no cutting has been done. Toward the southern part of the region Engelmann spruce gradually becomes the dominant and important tree, till in many forests in Colorado and Utah this tree furnishes the chief part of the saw timber. On account of the high altitude, snow lies late and comes early, so that the fire season is quite short and the danger necessarily lessened. The chief care here should be to conserve the moisture in the soil, since reproduction is usually good. Brush should be lopped and scattered, with occasional fire lines, unless it should be decided that the fire danger is serious, in which case brush should be piled and enough burned to reduce the danger to a minimum.

THE SOUTHWEST.

The forests of New Mexico and Arizona are included in this region, together with those of the southern portions of Colorado, Utah, Nevada, and California. The area is characterized by a very light rainfall and long, hot, dry summers. The danger from fire and the difficulty of obtaining satisfactory reproduction are very great. In deciding on the best method of brush disposal each case must be considered separately, but the question whether the danger from fire is great enough to allow the difficulties of procuring reproduction to be ignored should always be considered. The forests of the Southwest can be divided into four types: (1) Woodland, (2) yellow pine type, (3) Douglas fir type, and (4) spruce type.

Woodland type comprises the scattered forest of oak, juniper, and piñon, usually at elevations of from 5,000 to 6,500 feet and below the true timber belt. Cordwood and posts are about all that is cut here. There is usually an open cover of merchantable trees, with a scattered cover of different species of chaparral, but very little ground cover. Owing to the dryness of the soil, reproduction is sparse.

Here, where the ground is loose and comparatively bare and the slopes steep, the brush should be carefully lopped and scattered over the ground to prevent it from washing and to conserve moisture and protect the reproduction from stock. Where erosion is the chief danger, long low piles built along the side of the hill will prevent washing. Where the ground has already started to wash and gullies are forming or have formed, brush should be piled in them. Usually the cutting is so scattered in this type and the ground cover so slight that there is no need of fire lines. In rare cases, where cattle are scarce, good reproduction is found, with a good ground cover of grass. Here the brush should be piled and burned.

The yellow pine forest occurs above the woodland at elevations of from 6,500 to 8,000 feet. It is usually a pure forest. On many soils, unless very much overgrazed, there is a good ground cover of grass. The way to dispose of brush will depend upon the amount of reproduction and ground cover. Where there is a fair or good stand of reproduction, all brush should be piled and burned, except that where reproduction is very dense the piles should not be burned, since much young growth would be destroyed. Where there is little or no reproduction and the fire risk is not too great, tops should be lopped and scattered.

Douglas fir type occurs at from 8,000 to 9,000 feet elevation and is composed of varying proportions of Douglas and white fir. Usually the stands are fairly dense, with little ground cover and good reproduction, especially of the less desirable white fir. Here the chief danger from fire is within the first two years after logging. After that the leaves fall off the dead branches and the danger is greatly reduced.

All brush should be piled in small compact piles, but only enough piles should be burned to form effective fire lines. Burning the brush injures the soil and prevents the germination of Douglas fir. Wherever burning can be avoided, therefore, it is best not to burn. On steep, densely timbered slopes, where the soil is rich and loose, it would be better to scatter the lopped brush over the ground away from living trees to prevent erosion, and to pile and burn only the necessary fire lines.

Spruce type.—From 9,000 feet up to the limit of commercial timber Engelmann spruce is the dominant tree. It occurs usually in dense stands, with all ages and sizes represented. With it is often a large percentage of alpine fir. The ground is fairly moist and snow comes early and lies late, so that the danger from surface fire is relatively small. There is considerable danger from crown fires, however, and if once burned the forest is permanently destroyed. Here, as a rule, brush should be piled in small piles in the openings as far as possible from trees and reproduction, but burned only in fire lines. In some very dense stands, where the only danger is from crown fires,

it may be best to lop all branches and scatter them evenly over the ground. The brush will be weighted to the ground by the snow and will rot and will much sooner cease to be a menace to the forest than if left in piles.

THE BLACK HILLS.

In the Black Hills region of South Dakota two types of forest are found, spruce type and yellow pine forest.

Spruce type consists of a forest of white spruce sometimes containing a varying per cent of pine and aspen, found on all the moister situations, along stream beds, on northern slopes, and on the highest elevations. As yet very little cutting is being done in this type. On account of the amount of moisture in the soil and the very short dry seasons, with proper fire patrol, there is not any great danger from fire in this type.

Pine type.—By far the greater proportion of the forest in this region is pure yellow pine, and this is the type in which practically all the lumbering is done.

On northern slopes, where there are sufficient seed trees, there is invariably good reproduction. Here brush should be piled to get it from among the young growth, but not burned, except that fire lines should be constructed where the fire danger warrants it. On southern slopes, where the grass makes a dense turf, reproduction is often very poor or absent altogether. Here brush should be piled, and in some places burned, so that the breaks made in the turf by the burned piles may furnish places for the young pine seedlings to start. On dry open slopes, destitute of ground cover and reproduction, brush may be lopped and scattered, to furnish mulch and partial shade to protect the young seedlings; but if this is done fire lines should be constructed.

Strenuous efforts are being made to reduce the depredations of the Black Hills bark beetle, and practically all timber being cut on that forest is infested with these insects. But burning the brush does not destroy these beetles, as they attack only the main stems of living trees and do not go into the branches. By burning the slash many beneficial insects are likely to be destroyed, so that this method of brush disposal is likely to do more harm than good in the matter of holding the bark beetle in check.

MINNESOTA.

Lumbering in the Minnesota National Forest is confined to one type, namely, the white pine-red pine type. Reproduction of these two commercial species is pretty well assured, and the only problem is to keep fires out. For this reason it is best to pile and burn all brush. Burning in winter as the logging progresses has been found the cheapest and most satisfactory method.

